Maximizing Weapon-Mounted Laser Rangefinder Performance Through Proper Alignment

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Background

For those of us that are accustomed to using handheld laser rangefinders (LRF), little thought from the user is required to obtain an accurate range. The beam from the laser is aligned at the factory to the center of the crosshairs of the direct-view optics and the fieldof-view of the receiver is aligned to said crosshairs as well. All that is required of the user is to place the crosshairs on the target and press a button to obtain the range.

Figure 1. Example of a weapon-mounted LRF (Wilcox Industries RAPTAR). To achieve maximum performance, proper alignment must be performed between the LRF and the direct-view optics.

For weapon-mounted laser rangefinders (Figure 1), the direct-view optics (presumably a riflescope) are decoupled from the laser rangefinder itself and so it is required that the laser rangefinder be manually aligned by the user. Improper alignment will result in poor ranging capability as well as inaccurate range measurements. Therefore, understanding how to achieve proper alignment is critical and is the focus of this article.

Understanding the Effects of Misalignment

To maximize LRF performance you want to ensure that a maximum amount of the laser energy is focused on the target and not scattering off of adjacent areas – shown in Figure 2. Although the LRF laser is invisible, it's depicted here as the shaded gray area. The tapering off of the laser energy is also characteristic of how most laser beams appear, they are most intense in the middle and taper off as the beam grows larger. In this case, the beam divergence (angle at which it is spreading) is 1 milliradian.

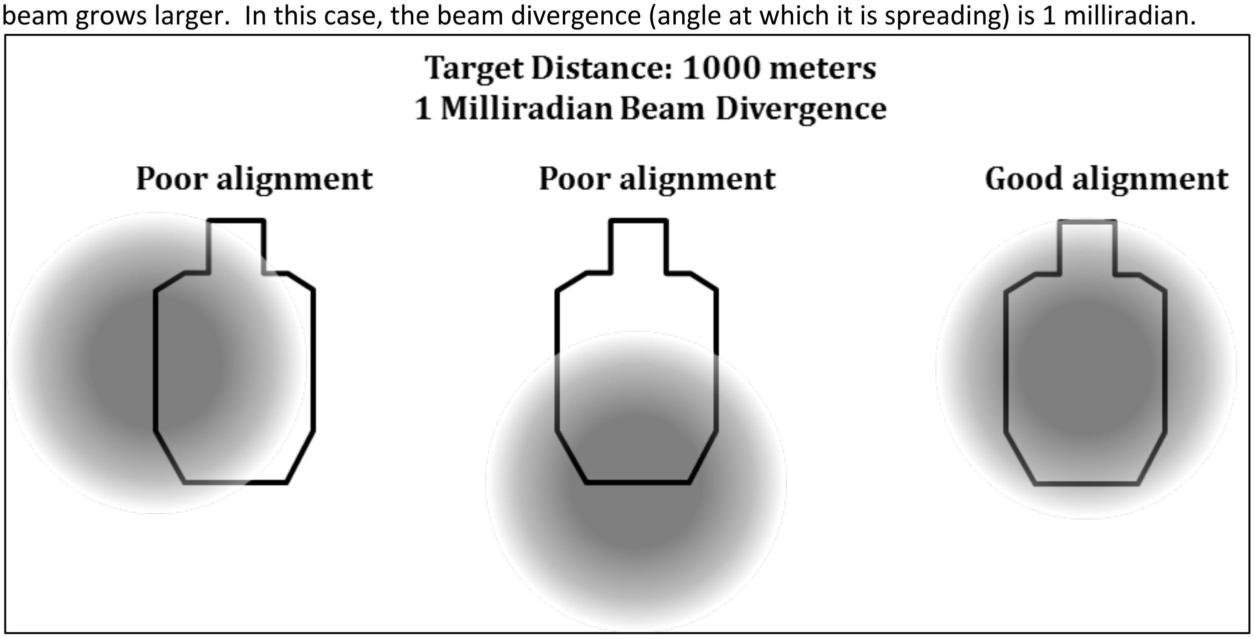

Figure 2. To achieve maximum performance, a weapon mounted LRF must be well aligned to obtain best energy on target.

The effects of an improper alignment become clear. The majority of the laser energy is no longer hitting the target. In this case, the laser is only misaligned by approximately 0.5 milliradians but as you can see, if there was any greater misalignment, then the laser may not hit the target at all. ***At 1000 meters, if the laser rangefinder is misaligned 0.5 milliradians low, then this could result in an error in the range measurement of up to 5 meters, which could drop your probability of hitting the target by as much as 30-40%.***

Understanding Co-Alignment of Lasers

Let's use the RAPTAR as an example of a weaponmounted laser rangefinder, which is shown here in Figure 3. The laser is transmitted from the aperture on the far right and received into the aperture on the far left. From the factory, the transmitter and the receiver for the laser rangefinder are already co-aligned. In addition, there is a red pointer laser and IR pointer laser transmitted from the far right aperture that are also coaligned to the laser rangefinder at infinity. What this effectively means is that all of lasers and the receiver are all looking exactly straight ahead. None of the lasers are crossing at any point in space. In other words, if you were to have all of the lasers on at one time and look through your riflescope, you would see something like what is shown in Figure 4 at 25 meters. The gray dot represents the LRF laser, the red dot is the red laser, and the green dot is the IR pointer laser.

Figure 3. The RAPTAR mounted on top of a riflescope is a perfect example of a separation of the laser rangefinder optics from the direct-view optics.

If you could see all of the lasers at 25 meters, all of the lasers would appear to be distinct from one another because they have not yet diverged to a large area. Because the LRF has not yet been aligned to the riflescope, the lasers could be located anywhere within the field of view of the riflescope. Typically, users are taught to use a special paper alignment target in order to best align the laser rangefinder to the correct point. While this is useful to obtain a coarse alignment, any slight misalignment becomes a much larger problem at distance. If you want to achieve 0.1 milliradian alignment from your riflescope to your laser rangefinder, then you must correctly align the position of the red laser to within 2.5 mm at 25 meters! That's extremely difficult to do and is the main cause of misalignments. The result of an improper alignment is that at some point, the center of your crosshairs and the lasers are actually crossing each other and then diverging away from each other.

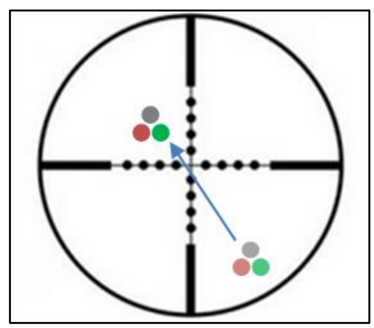

Figure 4. At 25 meters, all lasers will appear to be distinct and misaligned to the center of the crosshairs. Typically, users are taught to align the lasers to a special alignment target.

Effectively, you've just turned your 1500 meter laser rangefinder into a 500 meter laser rangefinder because of a small error in misalignment!

Maximize Performance through Proper Alignment Technique

The proper way to align your laser rangefinder to your riflescope to maximize laser rangefinder performance and avoid potential misalignments is to effectively perform a co-alignment at infinity – just as the manufacturer performed with the internal optics. To do this will require two steps, a course alignment at a short range, such as 25 meters, then a fine adjustment at long range, something like 8001000 meters. This is effectively infinity and at this point, the size of the laser beams are large – on the order of a meter or so – much larger than the physical separation between the laser rangefinder and your riflescope. Therefore, you just need to align the laser to the center of your riflescope. Let's take a look at how this works.

First, ensure that the LRF is securely mounted to the rifle and that the rifle is properly zeroed. Next, you're going to need a reflective target – something that will reflect the light right back at you. A car headlight, license plate, stop sign, or a reflective target made by nVisti are very effective for this.

- Place the target at approximately 25-50 meters
- Turn on the visible or IR laser

Using this target at a distance of 25-50 meters, perform the following actions, as shown in Figure 5. The red dot represents the laser and the dark red item is the reflective target.

1. Scan rifle near target until the laser spot is visible on the target
2. Note the offset between the laser spot and the scope's markings
3. Use the adjustments on the LRF to move the laser until it aligns with the scope crosshairs

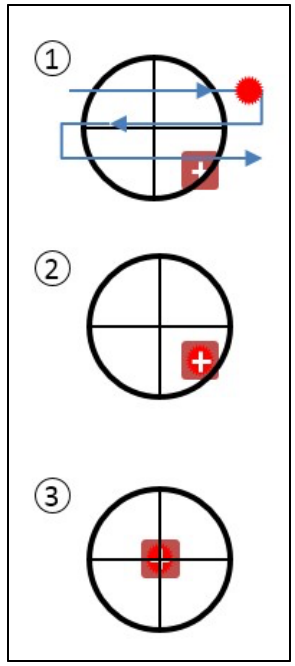

Figure 5. Steps 1-3 should be done at close and far ranges for coarse and fine alignment.

At this point, there is a great amount of parallax that you've just induced into your setup, so do not expect to be able to effectively range past 500 meters just yet. In order to complete the process, you need to perform a fine alignment at infinity, as discussed.

To do this, place the reflective target now at 800 to 1000 meters away. Recall, this is effectively an "infinite" distance when it comes to your optical system. Now, all you have to do is repeat steps 1-3 again that you just did at close range

Since the beam sizes are large at that distance and all of the light rays are essentially parallel to each other at that distance, all that you need to do is move the laser to the center of the crosshairs and this represents exactly where your LRF laser is at as well.

I often get the question on whether or not this is making the lasers cross your riflescope at that distance. The short answer is that no, they are not crossing. Because you've aligned at a distance of what we know is infinite with respect to the optics, the lasers and the riflescope are all perfectly co-aligned now. ***Performing these coarse an fine alignments ensures that the LRF is co-aligned to the center of your crosshairs to an extremely accurate degree, thus maximizing LRF performance.***

Alignment Tools

nVisti offers several variations reflective targets that can be obtained from the nVisti or Accuracy 1st Development Group web sites. The primary versions are flexible and can be placed in a backpack for easily carrying to the range or a hard target version that is permanently mounted on the range.